OBSERVATIONS ON SOME AUSTRALIAN FOREST INSECTS.

20. Insects attacking Hakea spp. in New South Wales.

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(Plate iv.)

[Read 30th September, 1964.]

Synopsis.

Two plant species, *Hakea gibbosa* and *H. sericea,* both of which occur in New South Wales, have become widely established on agricultural land in the Republic of South Africa. To assist with information of possible value in the biological control of these plant species in South Africa, a limited investigation of the insects attacking them on the Central Coast and adjacent highlands of New South Wales was made during 1962 and 1963. From the information obtained, it appears that some of the insect species may assume importance as agents for biological control.

Some insects of *H. teretifolia, H. dactyloides, H. salicifolia* and *H. leucoptera* are also recorded.

Introduction.

In the Republic of South Africa, the encroachment on some thousands of acres of valuable pastoral and agricultural lands by the three plant species *Hakea gibbosa* (Sm.) Cav., *H. sericea* Schrad., and *H. suaveolens* R.Br., which are indigenous to Australia, has caused concern to the Department of Agricultural Technical Services of the Republic. *H. gibbosa* and *H. sericea* are also established in the north island of New Zealand.

When a request was received from the Republic of South Africa for information on insects associated with *H. gibbosa* and *H. sericea* occurring in New South Wales, with a view to the possible biological control of the *Hakea* spp. in South Africa, a limited investigation and survey to obtain relevant basic information was commenced during October, 1962.

Very limited information concerning insects attacking *Hakea* spp. in New South Wales has been published, as these plant species have been of little economic importance, and in the area of investigation they generally occur most abundantly on the poorer type soils of Hawkesbury or Gosford sandstone origin, and on steep or poorly drained, or rocky sites, which are generally not suitable for agricultural or forestry purposes.

These observations were made in the Central Coast Region and the adjacent highlands, at an approximate latitude of 33° 25′ S., between the Hawkesbury River and Wyong. From records of the Department of Agriculture Citrus Experiment Station, Narara, over 47 years, the area has received an annual rainfall of from 24″ to 86″ with an average annual rainfall of about 50″, more or less evenly distributed throughout the year. The elevation of the land surface varies from sea-level on the coastal fringe to about 1,000 ft. altitude 6 to 10 miles westward of the coastline. The general climate of the area may be regarded as warm and moist, although some seasons may be comparatively dry, with occasional maximum daily temperatures over 100° during summer, while some severe frosts in certain localities during winter have been recorded.

As observations on the following insect species and the assessment of certain species as possible agents of biological control were made during approximately 12 months only, they are essentially preliminary, and the details recorded would vary from year to year, and from one locality to another within the area. Any reliable assessment of the insect species considered for introduction to other environments must necessarily be based on more extensive and intensive observations on details of the insects' biology, together with a study of ecological factors. Development of techniques for studying and excluding the numerous parasites and predators of the insect species selected would be essential.

Some of the insect species studied are apparently host specific, but others occur on more than one *Hakea* sp. and on *Banksia*, *Persoonia* and *Grevillea* spp., so that the possibility of the introduced insect species attacking other than the plant species intended, in the area to which its introduction was to be considered, would need to be critically examined.

It has recently been suggested (Pimentel, 1963) that allied species and genera of parasites, rather than the particular species apparently exerting a measure of biological control in the country of origin, sometimes offer more efficient biological control of a pest species in other countries, and that greater chances for success lie with the alien species. Also, the insects available for the control of a weed are not limited to those attacking it in its native habitat, but include species that attack closely allied or other plants in other areas (Wilson, 1964).

Some of the insect species listed as occurring on *Hakea teretifolia*, *H. dactyloides*, *H. salicifolia* and *H. leucoptera* thus may be of value in the control of *H. gibbosa* and *H. sericea* in other countries.

Immature and adult stages of most of the species listed are in the collection of the Forestry Commission of New South Wales.

A. Insects of Hakea gibbosa.

(During these investigations, flowering of *H. gibbosa* occurred from February to September, with the greatest number of flowers during May.)

COLEOPTERA: CERAMBYCIDAE.

(i) *Aphanasium australe* (Boisd.).

Damage by larvae of this species occurs from below ground level in the larger portions of roots, to 5 ft. above ground level in the stems. Near the attacked area, the stem becomes swollen and exudes a considerable quantity of a soft colourless gum.

Larvae work in separate but contiguous galleries from which a powdery or granular material is usually extruded. As many as fourteen larvae may occur in the one area of damage on either *H. gibbosa* or *H. sericea*, and larvae of various instars may be found during most months of the year. One generation occurs each year, and adults may emerge during the period November to March. Coloration of adults is variable, some specimens being all dark brown and others having a wide median longitudinal cream-coloured area on the elytra.

Throughout the area examined, only a few plants were attacked. Most of the plants observed did not appear greatly debilitated by the current attack, and many had survived previous heavy attack, so that at present it appears that this insect species is of doubtful value as an agent for biological control. Injured plants, or those growing in apparently unfavourable sites, are attacked more readily than healthy plants.

A wasp parasite, *Aulacostethus* sp., Aulacidae, was reared from larvae.

(ii) *Uracanthus triangularis* Hope.

Damage by this species is confined to the smaller stems and branches, and larvae occur singly. The portion of the plant distal to the area of attack may be killed, so that the effect on the plant is subsequent branching below the attacked area. Damage may extend for more than 2 ft. in a single stem, with an accompanying extrusion of powdery or granular frass and a clear jelly-like gum from the attacked area. There appears to be a single generation each year, the adults emerging during January to May. *Banksia* spp. are also attacked by this longicorn.

Damage by this species appears to be of little value for purposes of biological control.

CURCULIONIDAE.

(i) *Cydmaea binotata* Lea.

Adults are often numerous on plants from August to September, and from February to April, feeding on and destroying unopened buds and tender young shoots. Oviposition sometimes occurs in the buds which may then be destroyed by the larvae.

As this species, which appears to be host specific, causes extensive damage to the buds, it could be of potential value in biological control.

(ii) *Cydmaea major* Blkb.

This species appears to offer considerable possibilities for the biological control of *H. gibbosa*, and damage was widespread and severe in the area of investigation. The seeds are destroyed by larvae, and damage to buds by adults is similar to that by *C. binotata* adults. *C. major* also appears to be host specific.

After the adults have fed during the winter months on buds, young seed capsules, or either young or mature foliage, oviposition may occur during August and the warmer months in one or both of the distal horns of a seed capsule (Pl. iv). The young larva emerges from the horn and moves over the external surface of the capsule to commence boring at almost any location on its surface. Seed capsules may be attacked before they are about one-third developed, and attack is denoted by an exudation of a colourless gum at the point of entry by the larva.

Some larvae leave the capsule which they originally entered and destroyed, to attack other capsules on the same plant. This habit, and that of moving over the surface of the capsule from the horn instead of boring directly into the capsule, would appear to expose larvae to considerable predation or parasitism, although this was rarely evident during these investigations. Most of the first or spring generation of larvae emerge from the capsules by December to pupate in the soil.

Adults of the second generation commence emerging during November and December, so that there appear to be at least three generations during a year. Throughout the winter months adults may be active during warm, sunny days, or on bushes in sheltered situations, and during cold or wet days they shelter between capsules or in previously insect-damaged capsules which have partly opened. Coloration of male and female adults is similar.

Larvae of a braconid parasite were collected during November, and adults emerged during the subsequent October and November.

Damage to the horns of seed capsules by other insects appears to reduce greatly the number of oviposition sites, and thus the numbers of subsequent generation adults of *C. major* during the late summer and autumn, although the lengthy flowering period of *H. gibbosa* provides a sequence of oviposition sites for the adults of the various generations.

(iii) *C. major* var.

One adult specimen of a uniformly grey colour was collected on *H. gibbosa*.

(iv) *Enchymus punctatonotatus* Pasc. (v) *Perperus lateralis* Boisd. (vi) *P. melancholicus* Boisd. (vii) *Syarbis niger* Roel.

Adults of *E. punctatonotatus* were present in large numbers during spring, summer and autumn, damaging young shoots, seed capsules and the smaller stems of plants. Small numbers shelter in previously insect-damaged, and partly opened, seed capsules during winter.

Adults of *P. lateralis* were very numerous, damaging and destroying young foliage and shoots during early spring; adults of *P. melancholicus* and *S. niger* caused least damage. *P. lateralis* and *P. melancholicus* have been recorded as attacking *Pinus radiata* (Moore, 1963).

Damage by each of these species is regarded as insignificant for purposes of biological control, but it appears that damage to seed capsules by *E. punctatonotatus* limits oviposition sites for *C. major*.

EUMOLPIDAE.

Geloptera porosa Lea.

Damage by adults of this species is similar to that caused by *E. punctatonotatus* and is considered as insignificant for purposes of biological control, although such damage appears to limit oviposition sites for *C. major*. Adults occur in moderate numbers during the spring, summer and autumn, and a few specimens overwinter in sheltered situations.

Egg capsules are dark brown, spherical, roughened, and are placed around the distal end of foliage about ¼" below the tip. Adults have been recorded as damaging foliage of *P. radiata* (Moore, 1963).

Cleptor sp.

One adult was taken during March.

DIPTERA: CECIDOMYIIDAE.

Gen. et sp. indet.

Two species of this family from severely galled stems were associated with a complex of several species of Hymenoptera. Intensive investigations would be necessary to determine the part played by these species in the damage caused to the plant, and a revision of the taxonomy of the group appears necessary before accurate names can be applied to the species.

The galled stems and branches of plants die above the area of attack. Damage is widespread, and may be extensive on a single plant. It appears that the gall-forming cecidomyiids could be of considerable importance in the biological control of younger plants, provided that their numerous parasites and hyperparasites were screened.

The feeding site punctures caused by the adults of *Sertorius australis* Fairm. (Membracidae) may allow oviposition by the cecidomyiids to occur in the plant stems.

HEMIPTERA: CERCOPIDAE.

Philagra parva Don.

A single adult specimen only of this species was collected as it fed on a stem of *H. gibbosa* during September.

CICADELLIDAE.

Idiocerus sp.

One adult specimen only, feeding on a stem, was collected during April.

DERBIDAE.

Lamenia ? *kulia* Kirk.

One specimen only of this species was collected.

DIASPIDIDAE.

? *Remotaspidiotus* sp. nov.

This small white scale occurred in large numbers on the fruit and stems, and in small numbers on the foliage. It appeared to be particularly numerous on plants affected by the two species of cecidomyiids, but most specimens examined were parasitized. Because of parasitism, its role as a possible biological control agent was not evaluated under the conditions prevailing in the area of investigation.

FLATIDAE.

Siphanta granulicollis Stål.

A few specimens, feeding on stems and shoots, were collected during November and December.

ISSIDAE

Chlamydopteryx vulturnus Kirk.

A single specimen only of this species was collected.

MARGARODIDAE.

Auloiceryia ? *australis* (Maskell).

Small numbers of this species occurred on the stems and smaller branches during these investigations, and damage by them was not noticeable.

MEMBRACIDAE.

Sertorius australis Fairm.

Adults were numerous during the warmer months and small numbers persisted throughout the remainder of the year. Damage by adults of this species may allow oviposition in the stem tissues of the plants by the gall-forming cecidomyiids.

PSEUDOCOCCIDAE.
? *Paracoccus* sp.

A single specimen of this species was found on a stem during July.

TINGIDAE.
Tingis sp. near *hurdae* Drake.

A single specimen was taken during August.

HYMENOPTERA: PTEROMALIDAE (ASAPHINI).
Aphobetoideus sp.

Species of this genus have not been recorded previously from Australia (personal communication, E. F. Riek, 1963), and this species was reared from galled stems associated with the two species of cecidomyiids. It is apparently a hyperparasite. A complex of chalcidoid hyperparasites occurred in the galled stems with the cecidomyiids and torymids, and predation by mites on larvae and pupae of all the species concerned was severe during spring.

TORYMIDAE.
Megastigmus sp.

A few adults were reared from buds of *H. gibbosa*. A hard rounded gall is formed by a larva in the centre of a bud, and this apparently kills the bud.

LEPIDOPTERA: GELECHIIDAE.
Gen. et sp. indet.

The narrow, serpentine mines of larvae occur in the foliage, and they appear dark red on the surface. Larvae mine toward the tip of the needle, and during the last instars destroy the entire parenchyma of the distal one-quarter. Larvae have been collected during March and April, and damage to the plant is slight.

GEOMETRIDAE.
(i) *Oenochroma vinaria* Guenée.

Larvae destroy foliage during February to May; pupation occurs during April and the adults emerge during May. There appear to be two generations each year, and damage to a single plant is slight. Parasitism by ichneumonids is common.

(ii) Sp. ?

Larvae of this species severely damage the green immature seed capsules by eating in to the seed and destroying about three-parts of the capsule. A single larva only was found and it was not reared to the adult stage for identification, but damage was observed in three localities. Several seed capsules on the one bush may be severely damaged by a single larva, and should mortalities of the species from parasitism be absent from areas to which it may be introduced, it should offer some potential for biological control of *H. gibbosa*.

NOTODONTIDAE.
Danima banksiae Lewin.

In the area of investigations, the extent and intensity of damage by larvae were similar to that by *O. vinaria*. Larvae occur during spring, autumn and winter, and it appears that there are two main emergence periods for adults, with considerable overlap in each generation.

XYLORYCTIDAE.
Neodrepta luteotactella (Walk.).

Damage by larvae is widespread, and relatively common during the autumn and spring, but parasitism by ichneumonids, entomophagous gordian-type worms and other factors greatly reduce their numbers. A wasp (*Bracon* sp.: Braconidae) emerged during August.

During early instars larvae bore into the tender young shoots, later feeding on foliage, stems and the surface of seed capsules under cover of their silken webbing to

which excreta are attached, on foliage or between contiguous seed capsules. Stems are often girdled by feeding larvae but are rarely killed by them. Larvae pupate during October to December, and adults emerge from November to January. Damage to a plant is considered as unimportant for purposes of biological control.

Summary.—From these observations, the insect species at present appearing to offer the greatest potential importance in the biological control of *H. gibbosa* are *C. major*, *C. binotata*, the geometrid attacking the seeds, and the cecidomyiids which gall the stems.

B. Insects of Hakea sericea.

(During the period of observations, the plants flowered from early June to late October.)

COLEOPTERA: BUPRESTIDAE.
Gen. et sp. indet.

Larvae of this species mine below the thin outer bark of the stems, but damage does not appear to affect the plants adversely.

CERAMBYCIDAE.
Aphanasium australe.

Damage to *H. sericea* is the same as that occurring on *H. gibbosa.*

CURCULIONIDAE.
(i) *Cydmaea eucalypti* Lea.

Adults of this species feed on buds, shoots, foliage and probably seeds. They oviposit in some flower buds which may then be destroyed by the larvae. Adults were present in small numbers during April, and in large numbers during May, June and July. Numerous buds and young shoots were destroyed by larvae during July and August, and larvae were mining in foliage during November.

Because of the extent of damage to flower buds by this species, and its ability to survive in foliage and shoots of the host plant, it appears to offer a considerable potential for biological control of *Hakea sericea.*

(ii) *Enchymus punctatonotatus.* (iii) *Syarbis niger.*

Damage by these two species is similar to that on *H. gibbosa.*

EUMOLPIDAE.
Geloptera porosa.

Damage is similar to that on *H. gibbosa.*

SCOLYTIDAE.
(i) *Hypocryphalus moorei* Schedl. (ii) *Hypothenemus eruditus* Westw.

Damaged or debilitated stems are attacked by large numbers of larvae of the former species working beneath the thin bark. The stems from which these two species were reared were previously fire-damaged.

HEMIPTERA: DIASPIDIDAE.
? *Remotaspidiotus* sp. nov.

MEMBRACIDAE.
Sertorius australis.

PSEUDOCOCCIDAE.
Paracoccus sp. nov.

Damage by these three species is similar to that which they cause on *H. gibbosa.*

HYMENOPTERA: TORYMIDAE.
Megastigmus sp.

Damage by gall formation in a few buds is similar to that which occurs in buds of *H. gibbosa.*

LEPIDOPTERA: ANTHELIDAE.
Anthela ? acuta (Walk.).

A larva of this species was collected on foliage during May, and pupation occurred during July. Light damage only occurred.

GELECHIIDAE.
Gen. et sp. indet.

GEOMETRIDAE.
O. vinaria.

Damage by these two species on *H. sericea* was similar to that by the same species on *H. gibbosa.*

LIMACODIDAE.
? *Anapaea* sp.

A single larva was collected from foliage during June, but little damage occurred.

NOTODONTIDAE.
Teara variegata Walk.

A larva was collected on foliage during June, and damage was slight. Larvae attain a length of $2\frac{3}{4}''$ during late instars, and damage to foliage may be severe if a large number occurs on the one plant. This species is also recorded as attacking *P. radiata* (Moore, 1963).

OECOPHORIDAE.
Arachnographa micrastrella Walk.

Light damage to foliage and stems by larvae occurred during April, and it is considered that the species is of no value for biological control. It has also been recorded attacking *Pinus* spp. (Moore, 1963).

XYLORYCTIDAE.
(i) Gen. et sp. indet.

Larvae of this species destroy the seed by boring into the larger capsules. The species was not plentiful during these observations, but should large numbers occur they could be of considerable importance as a biological controlling agent.

(ii) *N. luteotactella.*

Damage is similar to that by the same species on *H. gibbosa.*

? (Family unknown.)

Small lepidopterous larvae mine beneath the thin bark of stems, and damage is similar to that caused by larvae of the Family Buprestidae.

Summary.—The insect species considered to be of greatest potential importance for the biological control of *H. sericea* are *C. eucalypti*, the xyloryctid attacking the seeds, and possibly *T. variegata.*

C. Insects of Hakea teretifolia (Salisb.) J. Britten.

(This plant species was in full flower from late December to late January, and was the *Hakea* sp. most plentiful and widespread occurring throughout the area of investigation. Although establishment of this and the following *Hakea* spp. has not been reported beyond Australia, insects associated with them are recorded.)

COLEOPTERA: CURCULIONIDAE.
(i) *Cydmaea diversa* Lea.

Larvae attack buds, foliage and flowers to such an extent that the setting of seed is greatly reduced. Adults occur in large numbers during January and February, and pupation occupies about 26 days.

(ii) *Cydmaea luctuosa* Pasc.

Damage by larvae was severe in the foliage of some plants. A larva was reared to the adult stage, pupation occupying about three weeks, and the adult emerged during March.

(iii) *Cydmaea crassirostris* Blkb.

The young green seed capsules which form in the absence of attack on buds and flowers by *C. diversa* may be destroyed by larvae of this species. Pupation occupies about three weeks, the adults emerging during March.

(iv) *E. punctatonotatus.*

Damage was more extensive than that on *H. gibbosa* and *H. sericea*, and many young green seed capsules were destroyed. Adults are numerous throughout the warmer months.

(v) *P. lateralis.*

Less damage occurred on *H. teretifolia* than on *H. gibbosa.*

EUMOLPIDAE.

G. porosa.

Damage was more severe than on *H. gibbosa* and *H. sericea*, and young green seed capsules were also attacked.

HEMIPTERA: COCCIDAE.

? *Coccus* sp.

One specimen only occurred on a stem.

DIASPIDIDAE.

(i) *Phaulaspis hakeae* (Maskell).

These small rounded orange-red scales were numerous on some plants in certain localities, but damage was not evident.

(ii) ? *Remotaspidiotus* sp. nov.

Scales occurred on stems and seed capsules.

FLATIDAE.

Siphanta acuta Walk.

A few specimens only occurred, and damage was not evident. The species has been reported as feeding on *P. radiata* (Moore, 1963).

MARGARODIDAE.

A. australis.

Specimens were more numerous on this plant species than on *H. gibbosa*, but damage was not evident.

MEMBRACIDAE.

S. australis.

Damage was similar to that on the other *Hakea* spp.

PSEUDOCOCCIDAE.

Paracoccus sp. nov.

A few specimens only occurred, and damage was not evident.

HYMENOPTERA: TORYMIDAE.

Megastigmus sp.

Large numbers occurred in buds and carpels, so that very few buds on some plants remained unaffected after heavy attack. This species offers effective control of the plants' ability to set seed.

LEPIDOPTERA: GELECHIIDAE.

Gen. et sp. indet.

Damage to flowers was severe in some areas, and the distinctive larvae, bearing alternate rose-red and white transverse bands, sheltered in fine webbing spun among

flowers near where they fed on the blossoms and opening shoot buds. Only small numbers occurred, and they were most numerous during early spring. Flowers of *Grevillea linearifolia* are also attacked by larvae of this species.

NOTODONTIDAE.
D. banksiae.
Damage was limited, and similar to that on *H. gibbosa.*

XYLORYCTIDAE.
(i) *Xylorycta strigata* Lewin.
Larvae bore in the small stems of *H. teretifolia, Banksia integrifolia, B. spinulosa, B. serrata* and *G. linearifolia,* killing attacked stems. Moderate numbers occurred in *Banksia* spp. and small numbers in *Hakea* spp.

(ii) *N. luteotactella.*
Damage was similar to that on other *Hakea* spp.

SUMMARY.—The insect species considered to be of greatest importance for the biological control of *H. teretifolia* are *C. diversa, C. crassirostris* and *Megastigmus* sp.

D. INSECTS OF HAKEA DACTYLOIDES (GAERTN.) CAV.
(Plants of this species were in full bloom during late November.)

HEMIPTERA: DIASPIDIDAE.
Phaulaspis hakeae (Maskell).
Large numbers occurred in some localities, but damage was not evident.

HYMENOPTERA: TORYMIDAE.
Megastigmus sp.
Numerous mortalities of buds occur from attack by this gall-forming wasp which appears to be the principal insect species limiting regeneration of *H. dactyloides.*

LEPIDOPTERA: GELECHIIDAE.
Gen. et sp. indet.
This is the same species as that which damages flowers of *H. teretifolia,* and damage is similar.

TORTRICIDAE.
Gen. et sp. indet.
The pale green larvae of this species damage numerous flowers of *H. dactyloides* and *G. linearifolia.* Adults are uniformly grey.

SUMMARY.—The insect species considered to be of greatest importance for the biological control of *H. dactyloides* is *Megastigmus* sp.

E. INSECTS OF HAKEA SALICIFOLIA (VENT.) B. L. BURTT.
HEMIPTERA: DIASPIDIDAE.
Phaulaspis hakeae (Maskell).
Larger populations than on *H. teretifolia* occurred on some plants, but damage was not evident.

LEPIDOPTERA: GRACILARIIDAE.
Acrocercops nr. *argyrodesma* (Meyr.).
Larvae mine in the young leaves and construct mines which are at first linear and then blotch in form. Larvae were numerous during December, and adults emerged during the same month. The life cycle occupies about five weeks at that time of the year.

SPHINGIDAE.
Coequosa triangularis Don.
Moderate damage occurred to foliage of *H. salicifolia, Banksia serrata* and *B. integrifolia,* and without the considerable control exerted by parasites damage may assume importance in the control of this *Hakea* sp. Larvae were reared on *Persoonia* sp.

SUMMARY.—The insect species considered to be of greatest importance in the biological control of *H. salicifolia* is *C. triangularis*, but its wide host range could detract from its importance.

F. INSECTS OF HAKEA LEUCOPTERA R.Br.

(This species was in full flower during early October. It occurs near the western extremities of the Central Western Slopes, where rainfall averages about 14″ per annum, and temperatures are high, with restricted rainfall, during the summer months.)

COLEOPTERA: CURCULIONIDAE.
Cydmaea ? *diversa*.

Damage to flowers was severe during October and November, and from pupation to the adult stage occupied about three weeks.

DIPTERA: CECIDOMYIIDAE.
Gen. et sp. indet.

Damage by larvae causes foliage to become distorted, and may be severe on some branches.

HEMIPTERA: MEMBRACIDAE.
Cornutipo scalpellum Evans.

Adults occurred in large numbers during April, May, September and October, and adults and nymphs were attended by large numbers of ants. Punctures in stems by feeding adults may allow oviposition by the cecidomyiids mentioned above.

PSYLLIDAE.
Aconopsylla sp. nov.

Large numbers of nymphs and a few adults occurred during April and May, and young shoots were severely affected by them.

HYMENOPTERA: TORYMIDAE (MEGASTIGMINAE).
Gen. et sp. indet.

Larvae produce a "pineapple-top" formation in buds which are galled. Attack may be moderate to heavy during April, and adults emerge during May.

LEPIDOPTERA: XYLORYCTIDAE.
Xylorycta sp.

Larvae bore in stems, and sometimes girdle the stems externally. Those collected during early October pupated during November and adults emerged during November. Damage may be severe on small plants.

SUMMARY.—The insect species considered to be of some potential importance in the control of *H. leucoptera* are *C.* ? *diversa*, the torymid forming bud-galls, and *Xylorycta* sp.

CONCLUSION.

From observations in the area of investigations on the Central Coast of New South Wales it is evident that fire contributes considerably to the spread of *Hakea* spp., and, should an area be kept free from fire, regeneration is very limited. Fire causes the thick woody fruits to open and shed the seeds which are undamaged by the fire. In areas where no fire had occurred, some plants had retained the unopened seed capsules for at least five years.

Fire has often damaged the stands of *Hakea* spp. in the Republic of South Africa (personal communication, Mr. D. Webb, 1963), so that it has apparently been a contributing factor in the spread, and increase in density, of the *Hakea* spp. in that area.

The insects recorded in this paper, and their plant associations, are summarized in Table 1.

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TABLE 1.

*Summary of Insect-*Hakea *spp. Associations.*
B. = Bud, F. = Flower, Fo. = Foliage, Fr. = Fruit, S. = Stem.

	H. gibbosa.	*H. sericea.*	*H. teretifolia.*	*H. dactyloides.*	*H. salicifolia.*	*H. leucoptera.*
COLEOPTERA						
BUPRESTIDAE	—	S.	—	—	—	—
CERAMBYCIDAE						
Aphanasium australe	S.	S.	—	—	—	—
Uracanthus triangularis	S.	S.	—	—	—	—
CURCULIONIDAE						
Cydmaea binotata	B., F., Fo.	—	—	—	—	—
C. crassirostris	—	—	Fr.	—	—	—
C. diversa	—	—	F. Fo., Fr.	—	—	—
C. ? diversa	—	—	—	—	—	F.
C. eucalypti	—	B., Fo.	—	—	—	—
C. luctuosa	—	—	Fo.	—	—	—
C. major	B., Fo., Fr.	—	—	—	—	—
C. major var.	?	—	—	—	—	—
Enchymus punctatonotatus	Fo., Fr., S.	Fo., Fr., S.	Fo., Fr., S.	—	—	—
Perperus lateralis	Fo.	—	Fo.	—	—	—
P. melancholicus	Fo.	—	—	—	—	—
Syarbis niger	Fo.	Fo.	—	—	—	—
EUMOLPIDAE						
Geloptera porosa	Fo., Fr. S.	Fo., Fr., S.	Fo., Fr. S.	—	—	—
SCOLYTIDAE						
Hypocryphalus moorei	—	S.	—	—	—	—
Hypothenemus eruditus	—	S.	—	—	—	—
DIPTERA						
CECIDOMYIIDAE						
Gen. et sp. indet.	S.	—	—	—	—	—
„ „ „ „	S.	—	—	—	—	—
„ „ „ „	—	—	—	—	—	Fo.
HEMIPTERA						
CERCOPIDAE						
Philagra parva	S.	—	—	—	—	—
CICADELLIDAE						
Idiocerus sp.	S.	—	—	—	—	—
COCCIDAE						
? Coccus sp.	—	—	S.	—	—	—
DERBIDAE						
Lamenia kulia ?	S.	—	—	—	—	—
DIASPIDIDAE						
Phaulaspis hakeae	—	—	S.	S.	S.	—
Remotaspidiotus sp.	Fo., Fr., S.	S.	Fr., S.	—	—	—
FLATIDAE						
Siphanta acuta	—	—	S.	—	—	—
S. granulicollis	S.	—	—	—	—	—
ISSIDAE						
Chlamydopteryx vulturnus	S.	—	—	—	—	—
MARGARODIDAE						
Auloicerya australis	S.	—	S.	—	—	—
MEMBRACIDAE						
Cornutipo scalpellum	—	—	—	—	—	S.
Sertorius australis	S.	S.	S.	—	—	—
PSEUDOCOCCIDAE						
Paracoccus sp. nov.	S.	S.	S.	—	—	—
PSYLLIDAE						
Aconopsylla sp. nov.	—	—	—	—	—	Fo.
TINGIDAE						
Tingis nr. *hurdae*	S.	—	—	—	—	—
HYMENOPTERA						
PTEROMALIDAE						
Aphobetoideus sp.	S.	—	—	—	—	—
TORYMIDAE						
Megastigmus sp.	B.	B.	B.	B.	—	B.

TABLE 1.—*Continued.*

	H. gibbosa.	*H. sericea.*	*H. teretifolia.*	*H. dactyloides.*	*H. salicifolia.*	*H. leucoptera.*
LEPIDOPTERA						
ANTHELIDAE						
Gen. et sp. indet.	—	Fo.	—	—	—	—
GELECHIIDAE						
Gen. et sp. indet.	Fo.	Fo., F.	—	F.	—	—
GEOMETRIDAE						
?	Fr.	—	—	—	—	—
Oenochroma vinaria	Fo.	Fo.	—	—	—	—
GRACILARIIDAE						
Acrocercops nr. *argyrodesma* ..	—	—	—	—	Fo.	—
LIMACODIDAE						
Anapaea ? sp.	—	Fo.	—	—	—	—
NOTODONTIDAE						
Danima banksiae	Fo.	—	Fo.	—	—	—
Teara variegata	—	Fo.	—	—	—	—
OECOPHORIDAE						
Arachnographa micrastrella ..	—	S., Fo.	—	—	—	—
SPHINOIDAE						
Coequosa triangularis	—	—	—	—	Fo.	—
TORTRICIDAE						
Gen. et sp. indet.	—	—	—	F.	—	—
XYLORYCTIDAE						
Neodrepta luteotactella	Fo., Fr., S.	Fo.. Fr., S.	Fo., Fr., S.	—	—	—
Xylorycta strigata	—	—	S.	—	—	—
Xylorycta sp.	—	—	—	—	—	S.
Gen. et sp. indet.	—	Fr.	—	—	-	—
FAMILY unknown	—	S.	—	—	—	—

Curculionidae, Derbidae, Eumolpidae, Flatidae, Issidae, Tingidae); Miss H. M. Brookes, Waite Agricultural Research Institute, Adelaide, South Australia (Margarodidae, Pseudococcidae); Mr. I. F. B. Common, Division of Entomology, C.S.I.R.O., Canberra (Geometridae, Gracilariidae, Notodontidae, Oecophoridae, Xyloryctidae); Dr. J. W. Evans, Director, The Australian Museum, Sydney (Cicadellidae, Membracidae); Mr. G. F. Gross, South Australian Museum, Adelaide (Curculionidae); Mr. E. F. Riek, Division of Entomology, C.S.I.R.O., Canberra (Pteromalidae, Torymidae); Dr. K. E. Schedl, Lienz, Osttirol, Austria (Scolytidae); Mr. C. N. Smithers, The Australian Museum (Cerambycidae, Sphingidae); Mr. K. L. Taylor, Division of Entomology, C.S.I.R.O., Canberra (Psyllidae). The identifications of the *Hakea* spp., for which the writer is grateful, were made by Dr. Mary Tindale, of The National Herbarium, The Royal Botanical Gardens, Sydney. Thanks are expressed to my colleague, Mr. P. Hadlington, for criticism of the manuscript and for the photography.

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EXPLANATION OF PLATE IV.

Upper seed capsule showing hole made by larva of *Cydmaea major* Blkb. when emerging from capsule of *Hakea gibbosa* to pupate. The distal horns, in which oviposition by adults occurs, are shown on the lower capsule.

Photo by P. Hadlington.